

The X-ray/UV warm absorber in NGC 7469



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- First high-resolution soft X-ray spectrum taken by RGS on XMM-Newton, in December 2000
- A UV spectrum was obtained by FUSE a year before

NGC 7469

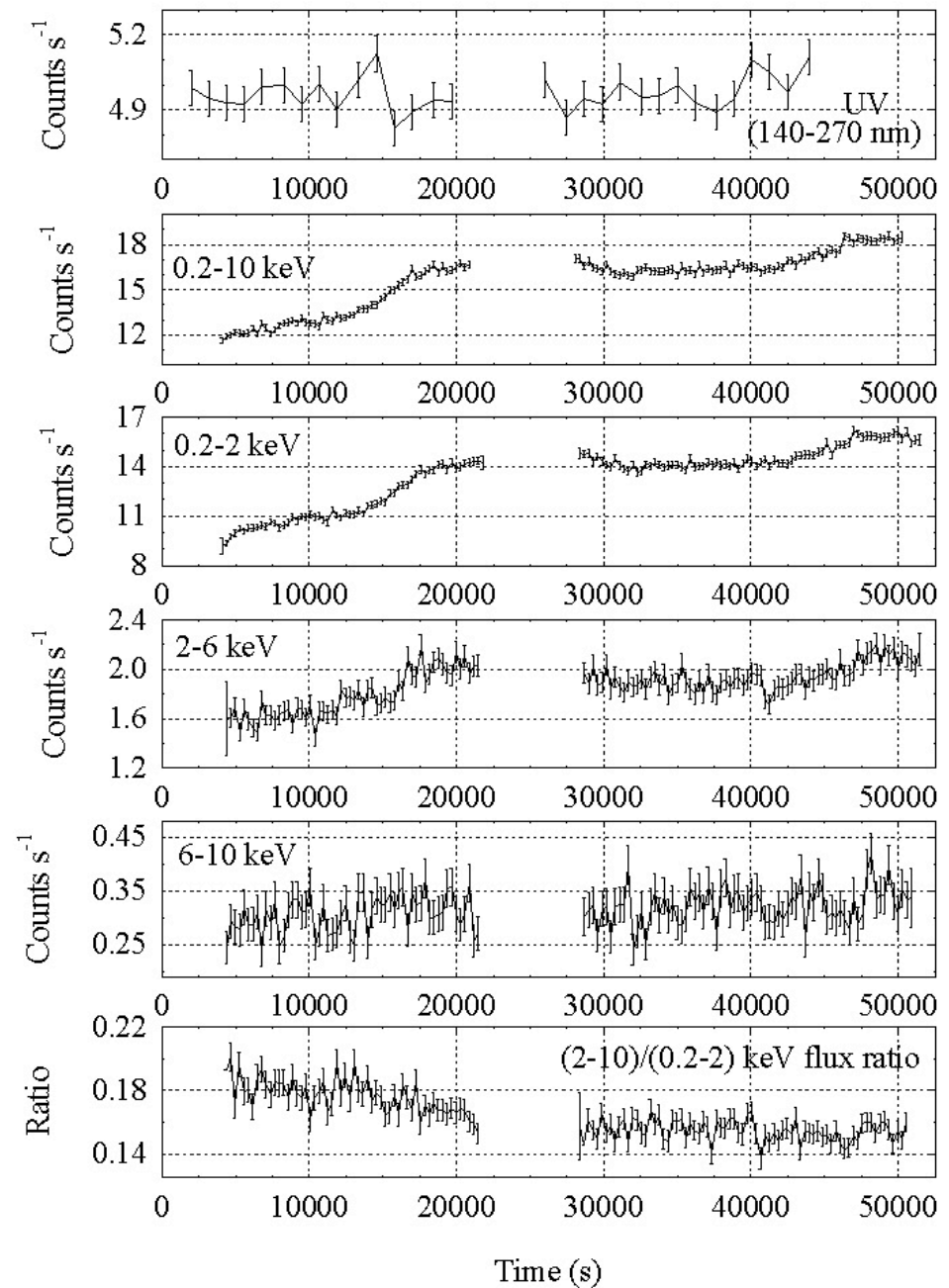
- The combined analysis of the X-ray and UV data has given us an important new insight into the X-ray/UV warm absorber

- **Multiwavelength studies of the Seyfert 1 galaxy NGC7469. I - Far UV observations with FUSE** *G. A. Kriss, A. J. Blustin, G. Branduardi-Raymont, R. F. Green, J. Hutchings and M. E. Kaiser, A&A, in press; astro-ph/0302552*

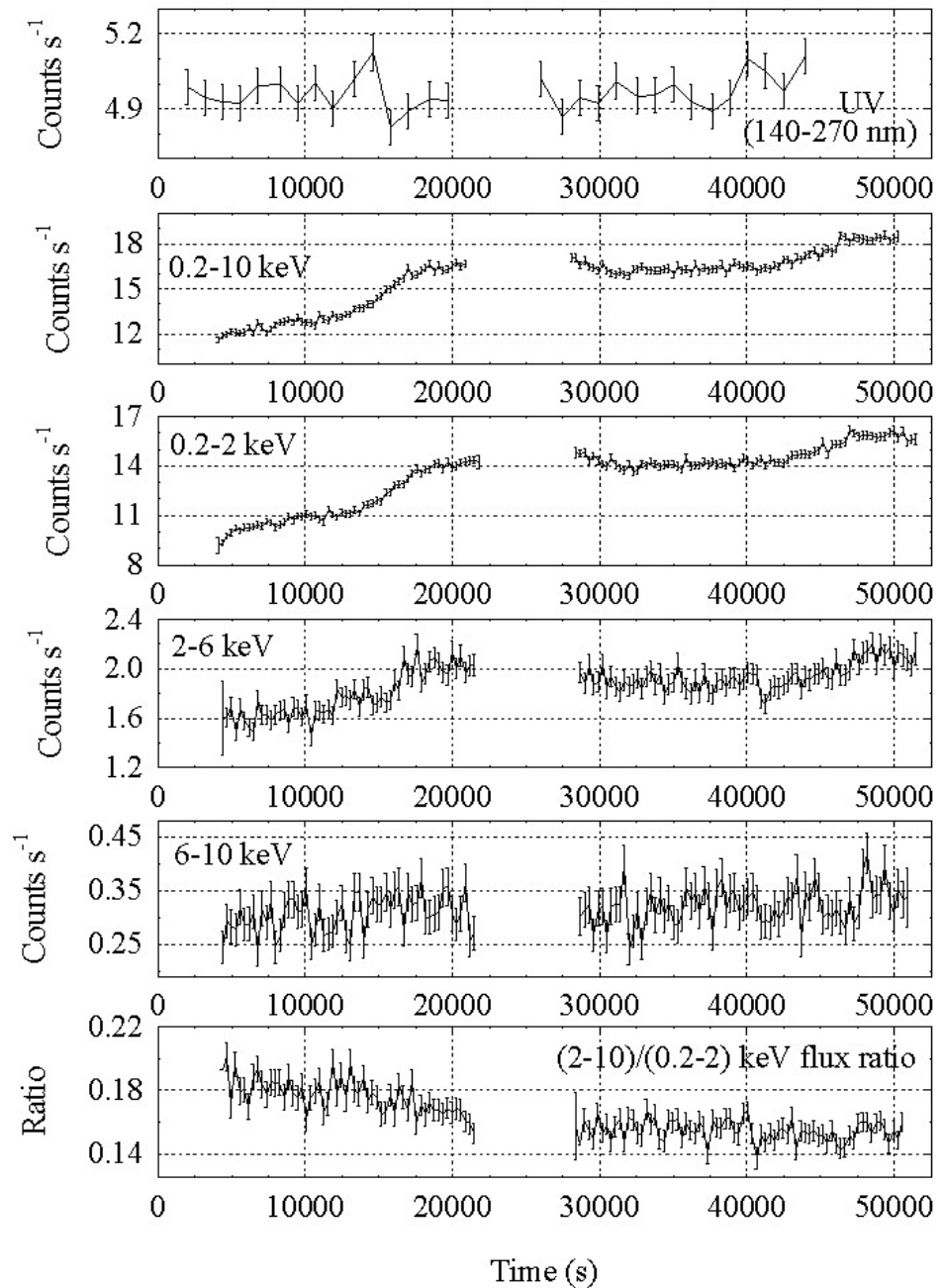
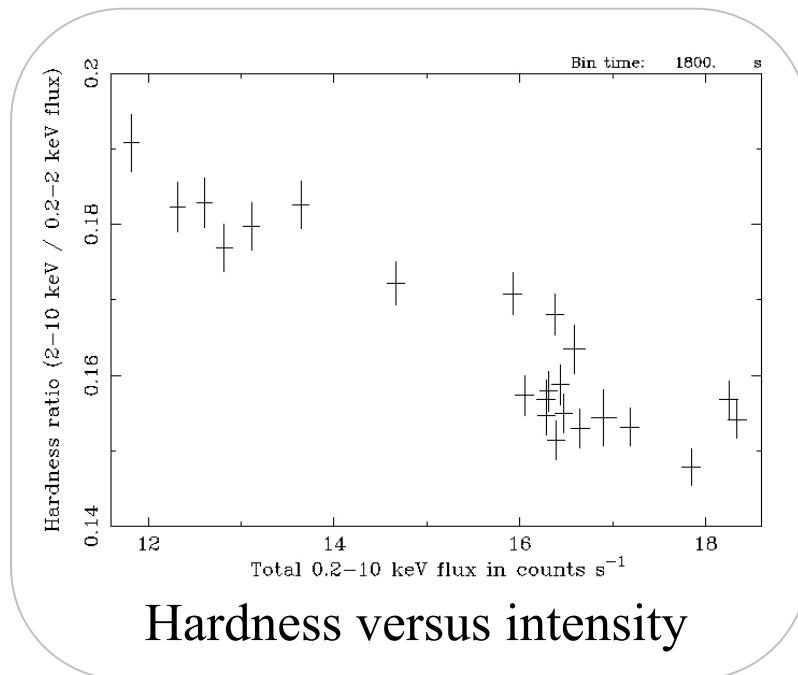
- **Multiwavelength studies of the Seyfert 1 galaxy NGC7469. II - X-ray and UV observations with XMM-Newton** *A. J. Blustin, G. Branduardi-Raymont, E. Behar, J. S. Kaastra, G. A. Kriss, M. J. Page, S. M. Kahn, M. Sako and K. C. Steenbrugge, A&A, in press; astro-ph/0302551*

- This talk summarises the results of this project and discusses its future prospects

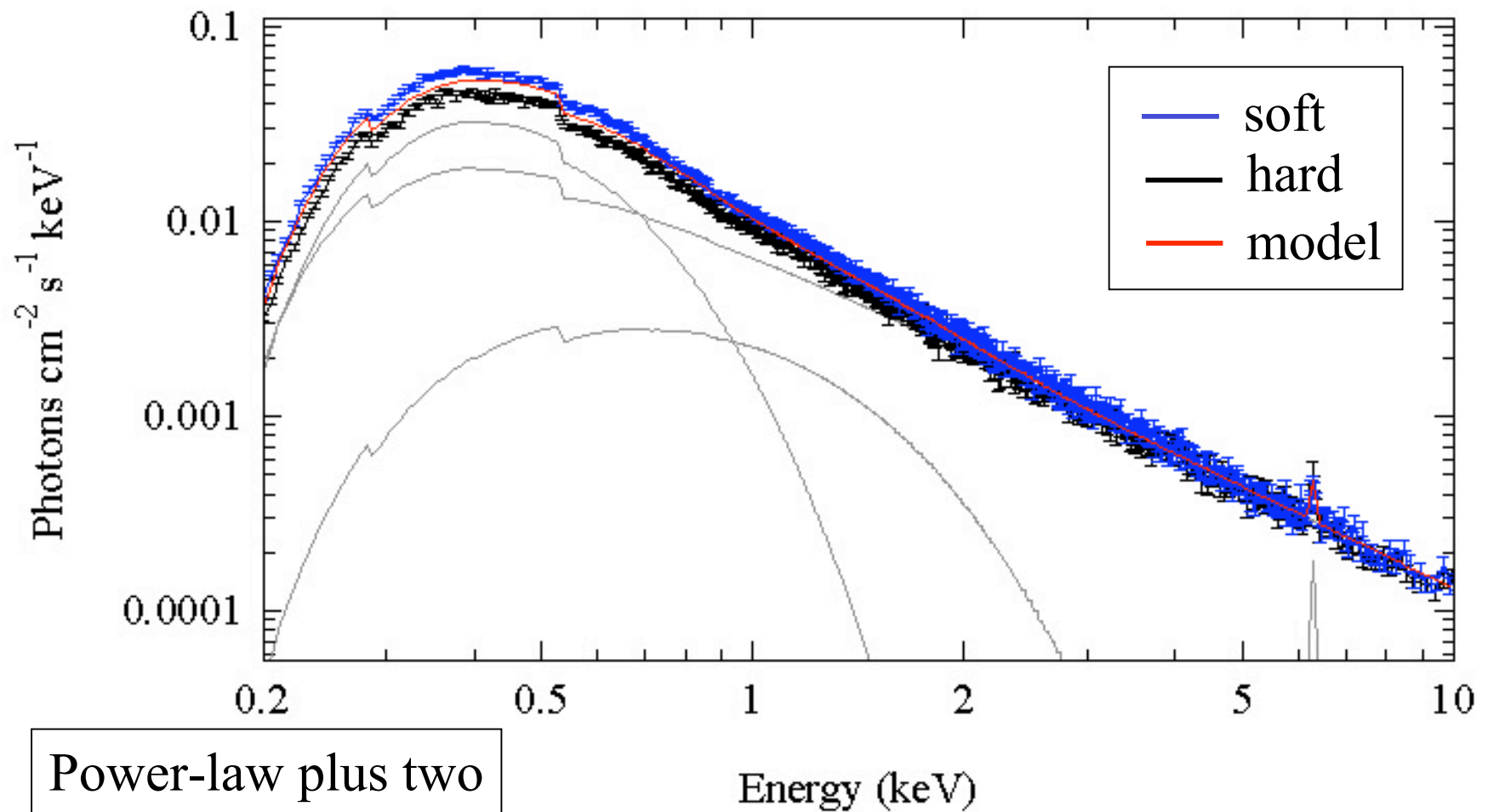
X-ray and UV variability seen by XMM-Newton



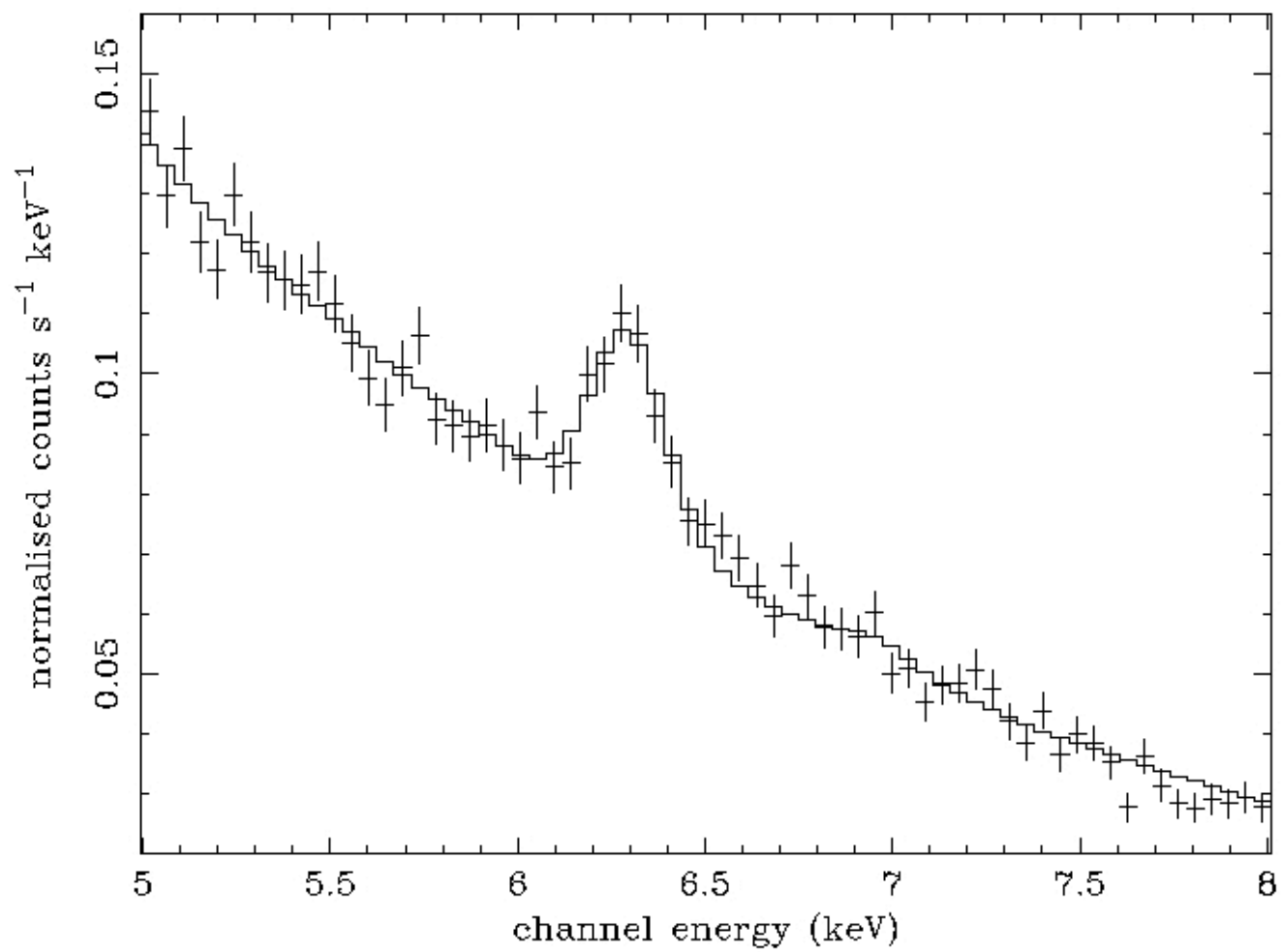
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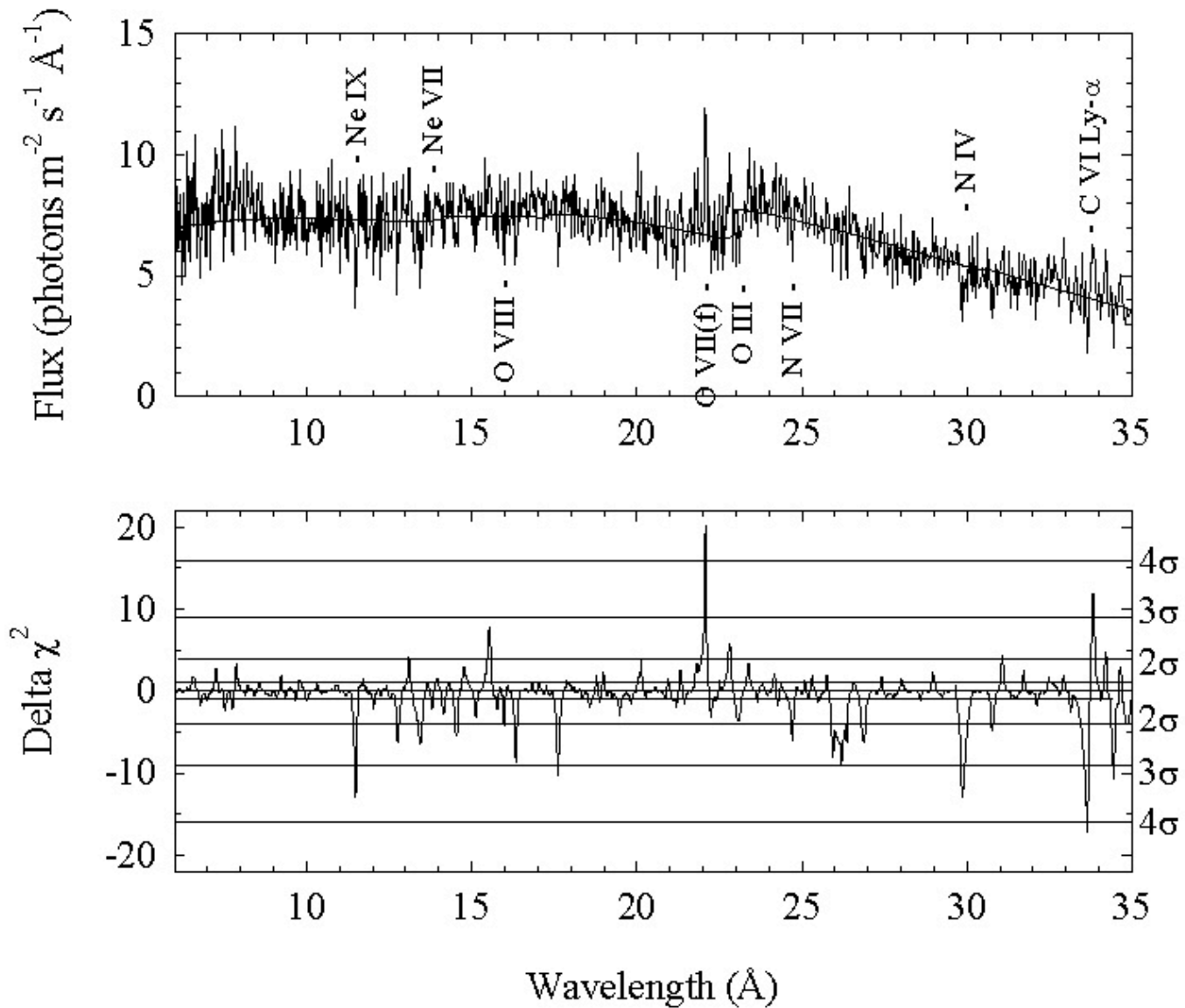
0.2-10 keV EPIC-pn spectrum



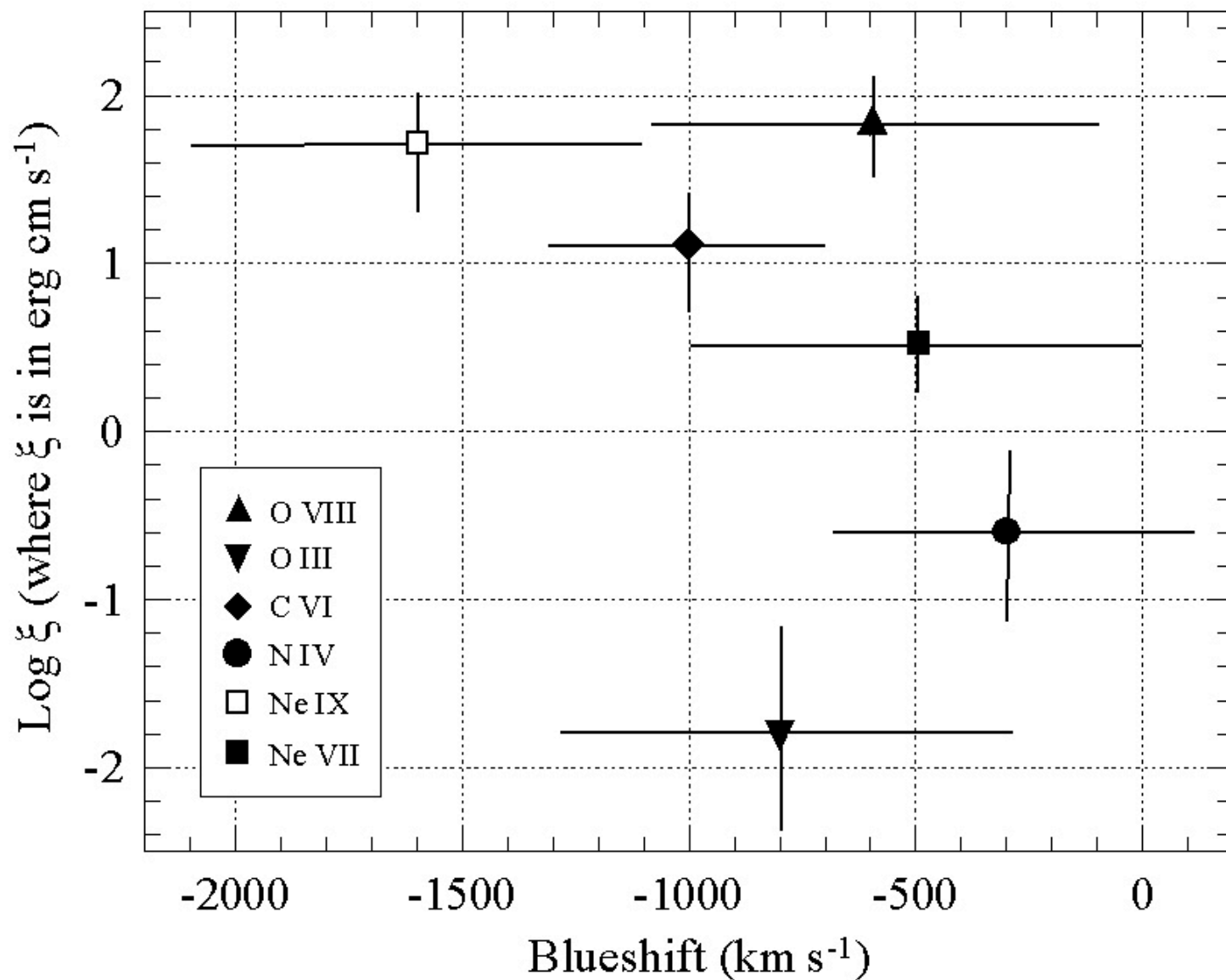
Narrow iron K α line



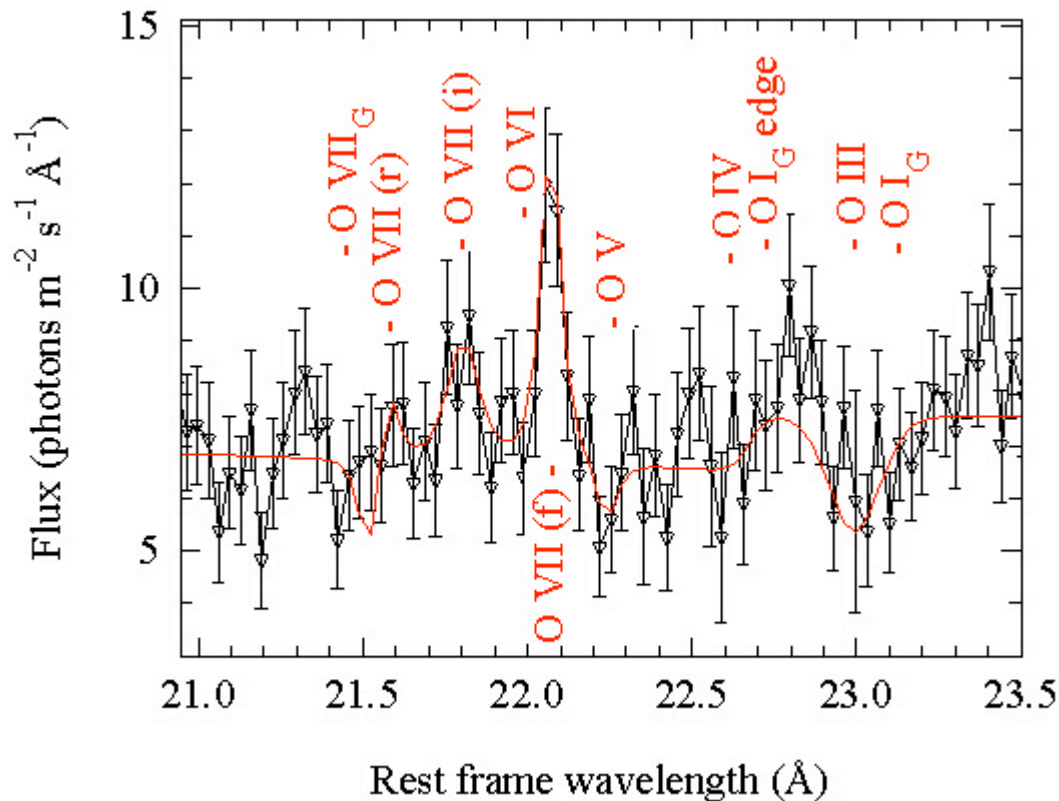
Significance of narrow spectral features



Ionisation level versus blueshift



O VII triplet diagnostics



w = flux of O VII resonance line
 z = flux of O VII forbidden line
 $(x + y)$ = flux of O VII intercombination lines
 u = flux of O VIII Ly α line

Density

$$R = \frac{z}{x + y}$$

Ionisation level

$$X_{\text{ion}} = \frac{u}{w}$$

Summary - X-ray warm absorption

NGC 7469 has an outflowing, multi-phase X-ray warm absorber:

- $\text{Log } \xi = -2 \text{ to } 2$
- Average blueshift $-800 \pm 100 \text{ km s}^{-1}$

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- Average blueshift $-800 \pm 100 \text{ km s}^{-1}$
- High-ionisation phase best constrained:
 - $\text{Log } \xi = 1.6^{+0.7}_{-0.4}$
 - $N_{\text{H}} = (1.5 \pm 0.9) \times 10^{20} \text{ cm}^{-2}$; low column so no iron absorption observed

Summary - X-ray warm emission

- We identify four narrow emission lines: O VII(f), O VII (i), O VIII Ly α and C VI Ly α
- O VIII Ly α and C VI Ly α have P-Cygni profiles
- O VII(f) has blueshift = $-400 \pm 200 \text{ km s}^{-1}$ and is unresolved

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- Ionisation level of emitter consistent with that of absorber
 - Emitter: $\log \xi = 2.2^{+0.3}_{-0.2}$
 - Absorber: $\log \xi = 1.6^{+0.7}_{-0.4}$
- Density implied by f/i ratio is less than 10^{10} cm^{-3}

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- UV#1:
- blueshift = -569 km s^{-1}
 - O VI column $\sim 8 \times 10^{14} \text{ cm}^{-2}$; upper limit $1.5 \times 10^{18} \text{ cm}^{-2}$
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- UV#2:
- blueshift = -1898 km s^{-1}
 - O VI column $\sim 8 \times 10^{14} \text{ cm}^{-2}$
 - covers $\sim 90\%$ of continuum and broad line emission

The X-ray - UV connection

- UV#1:
- Has best match for X-ray absorber blueshift
 - Using a SED based on the RGS and FUSE spectra, calibrated by the relative X-ray and UV fluxes observed by XMM, Xstar modelling shows that the O VII, O VIII, O VI and HI (from HST-FOS) all correspond to a warm absorber with:
 - $\text{Log } \xi = 2.2, N_{\text{H}} = 3.5 \times 10^{20} \text{ cm}^{-2}$

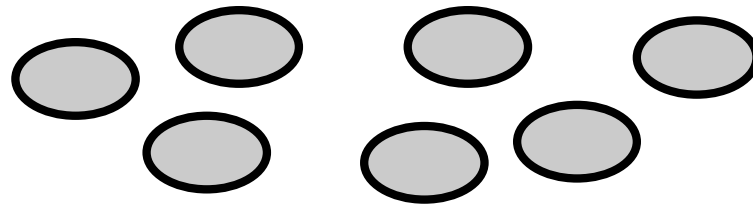
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- UV#2:
- Blueshift too high to correspond to X-ray absorber
 - Total column of absorber is too low for it to be visible in RGS spectrum

Overall model - NGC 7469 warm absorber

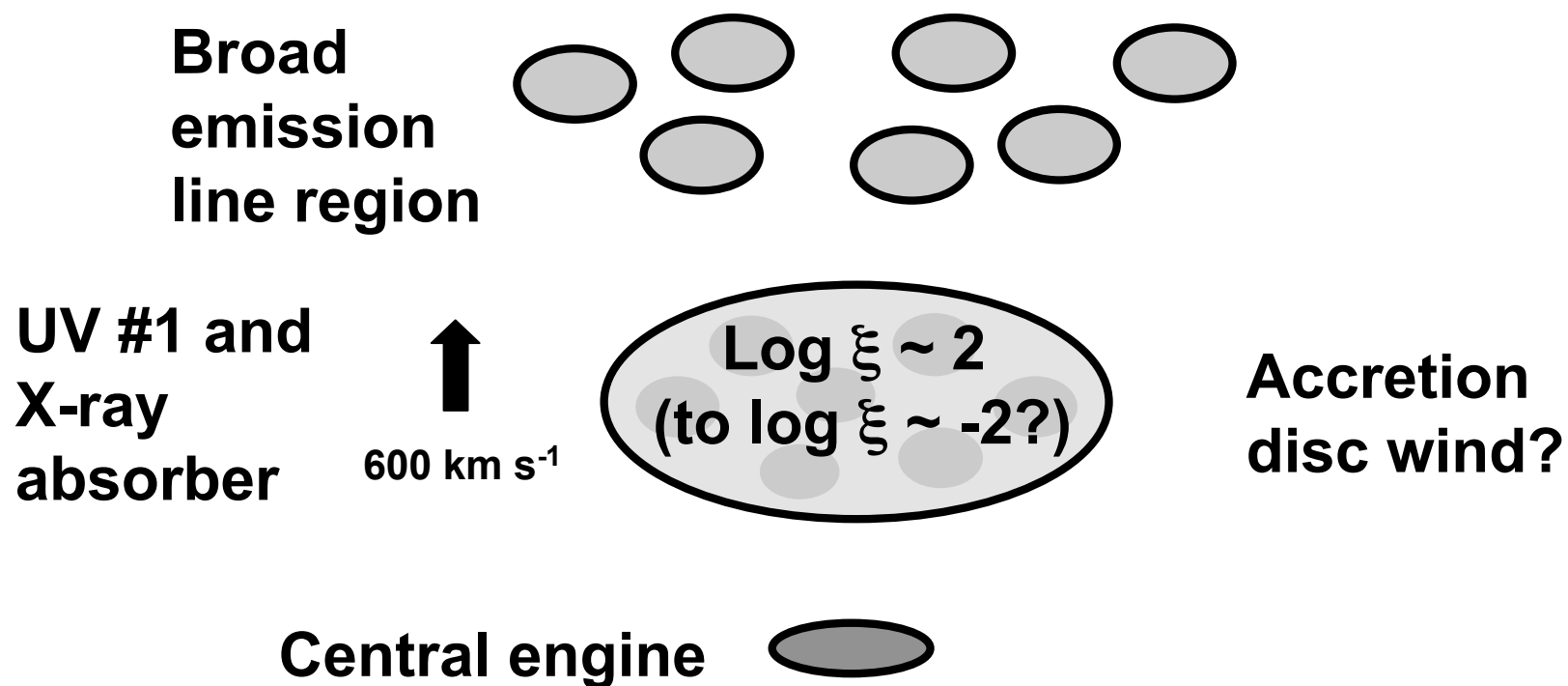
**Broad
emission
line region**



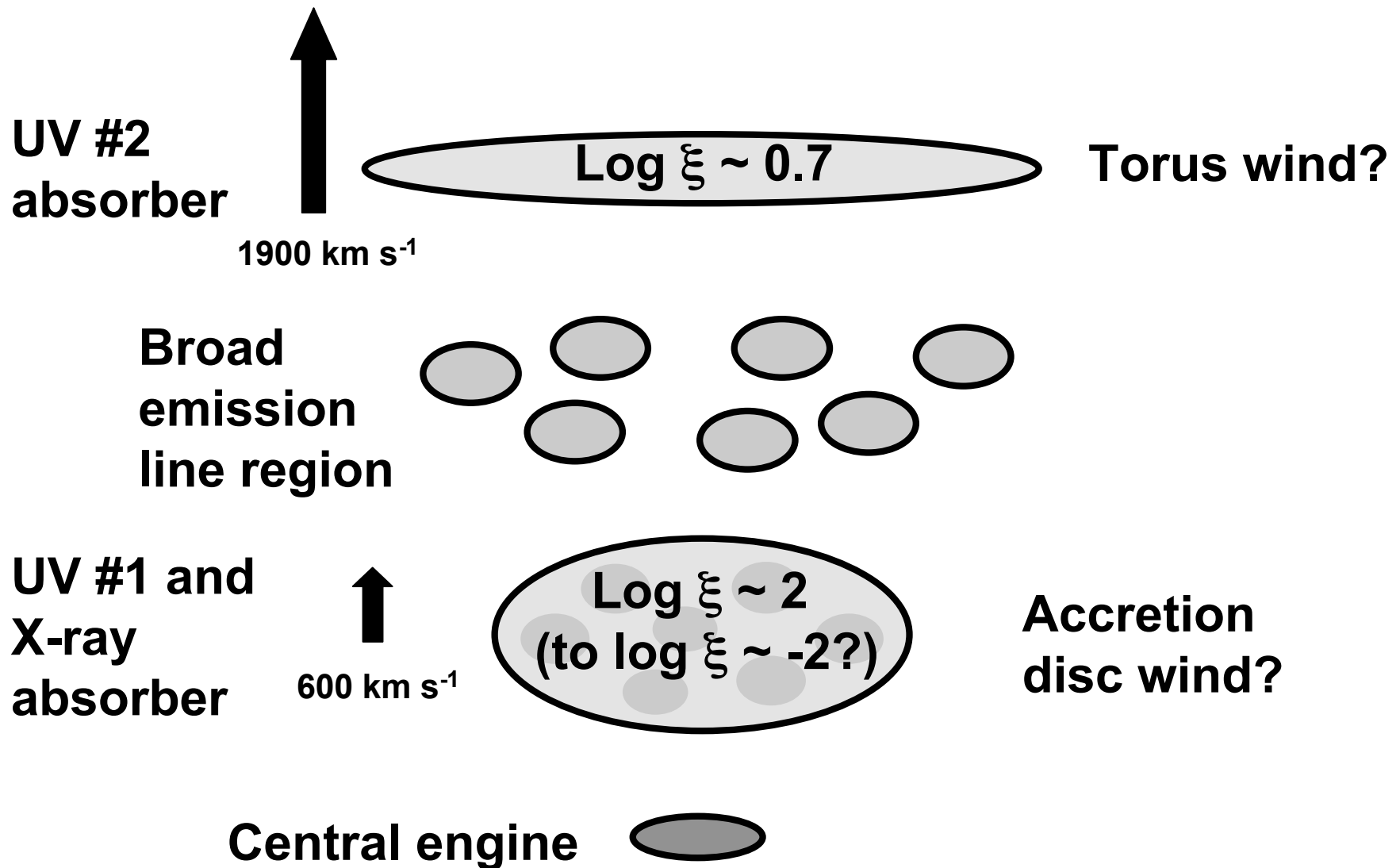
Central engine



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The future

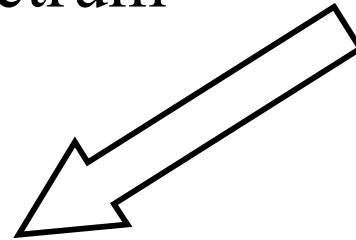
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The future

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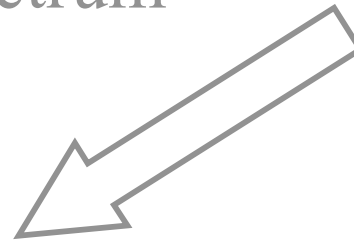
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XMM-Newton AO-3 and FUSE Cycle 5 proposals
for long simultaneous observations

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For a future X-ray spectroscopy mission:

- this project demonstrates the scientific value of having a co-aligned dedicated UV spectrometer on board